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New *rust* species and hosts from Northern Areas of Pakistan

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Abstract — During a survey of rust fungi of Northern Areas of Pakistan, *Puccinia aegopodii* and *P. rhytismoides* were collected as new to the Indian subcontinent. The uredinial state of *Chrysomyxa pyrolae* is described for the first time from Pakistan on *Pyrola rotundifolia* subsp. *karakoramica,* a new host. *Puccinia swertiae* is reported as a new record for Northern Areas, and *P. oniwaensis* is recorded on *Persicaria orientalis*, a new host.

Key words — Deosai Plains, Fairy Meadows, *Uredinales*

Introduction

Most parts of Northern Areas lie within the watersheds of the Himalaya, Hindu Kush, and Karakoram mountain ranges. Climatic conditions vary widely in the Northern Areas ranging from the monsoon influenced moist temperate zone in the western Himalayas to the semi-arid cold desert in the Northern Karakoram and Hindu Kush. The Northern Areas of Pakistan are well known for their biodiversity. Although these areas contain about 3000 plant species and are floristically rich, they have not been thoroughly surveyed for rust fungi and only approximately 71 species have been reported to date (Ahmed 1956a,b; Gjaerum & Iqbal 1969; Kakishima et al. 1993a,b; Kaneko 1993; Khalid et al. 1995; Khalid & Iqbal 1996, 1997a,b; Ahmed et al. 1997; Sultan et al. 2006a,b, 2008; Iqbal et al. 2008, 2009; Afshan & Khalid 2009; Afshan et al. 2009, 2010, 2011; Ishaq et al. 2011; Khalid & Saba 2011; Saba & Khalid 2011). During our 2010–2011 rust collection trips in the Northern Areas, we discovered *Puccinia aegopodii* and *P. rhytismoides,* both new for the Indian subcontinent and which we report with new hosts and other rust fungi new for these areas of Pakistan.

Materials & methods

Rust fungi were collected from Deosai Plains and Fairy Meadows, Northern Areas, Pakistan. Healthy plants with inflorescences and fruits were collected for accurate

identification. Host plants were identified by comparing them with specimens in the herbarium of the Department of Botany, University of the Punjab, Lahore (LAH).

Free hand sections of infected portions of material and spores were mounted in lactophenol. Semi-permanent slides were prepared by cementing cover slips with nail lacquer (Dade & Gunnell 1969). Preparations were observed under a NIKON YS 100 microscope. Drawings of spores were made by using a Camera Lucida (Ernst Leitz, Wetzlar, Germany). Spores were measured using an ocular micrometer (Zeiss, St Albans, Hertfordshire, England). At least thirty spores were measured for each spore stage. Measurements include the usual range and the arithmetic means; extremes are given in parentheses.

Taxonomy

Chrysomyxa pyrolae (DC.) Rostr., Bot. Centralbl. 5: 127 (1881). Fig. 1

Spermogonia, Aecia and Telia not seen. Uredinia scattered evenly on abaxial surface of leaves, *Caeoma*-like with delicate, one-layered peridium, orange-yellow, round, surrounded by ruptured peridium. Urediniospores globose, obovoid, ellipsoid to polyhedral, hyaline to subhyaline, sometimes with yellowish contents, produced in chains, (15–)18–22 × (18–)22–29 µm (mean 19.8 × 24.7 µm); wall hyaline, 1–2 µm thick, densely verrucose.

Material examined: **PAKISTAN**, **Northern Areas**, Fairy Meadows, on leaves of *Pyrola rotundifolia* subsp. *karakoramica* (Křísa) Y.J. Nasir (*Ericaceae*), with II stage, 23 Jul 2010, coll. & det. Malka Saba 12 (LAH).

Comments: The aecial stage of *Chrysomyxa pyrolae* was reported on cones of *Picea smithiana* (Wall.) Boiss. from Fairy Meadows by Kaneko (1993) and Ahmad et al. (1997). Its uredinial stage from the same locality is newly recorded for Pakistan, and *Pyrola rotundifolia* subsp. *karakoramica* is a new host for this rust fungus.

Puccinia aegopodii (Schumach.) H. Mart., Prodr. Fl. Mosq., Ed. 2: 226 (1817). Fig. 2

Spermogonia, Aecia and Uredinia not seen. Telia amphigenous, predominantly hypophyllous, minute, rounded, aggregated, surrounded by ruptured epidermis, pulverulent, black. Teliospores ellipsoid or oblong, cinnamon brown to dark brown, not or slightly constricted at septum, rounded at both ends, sometimes attenuated below, (12–)16–22 × (22–)26–35 µm (mean 18.7 × 30.3 µm); wall dark brown to chestnut brown, 1–2(–2.5) µm, germ pores apical, sometimes subapical or near septum in distal cell, adjacent to septum in proximal cell, mostly with hyaline dome-shaped, up to 3 µm high papilla; pedicel hyaline, short, deciduous, 5–6 × 2–9 µm.

Material examined: **PAKISTAN**, **Northern Areas**, Fairy Meadows, on leaves of *Aegopodium alpestre* Ledeb. (*Apiaceae*), with III stage, 23 Jul 2010, coll. & det. Malka Saba 13 (LAH). **GERMANY**, **Baden-Württemberg**, Donautal, Inzigkofen, am Strässchen zum Nickhof, kurz vor dem Nickhof, on leaves of *Aegopodium podagraria* L., 16 May 2010, leg. O. Holdenrieder and R. Berndt (ZT Myc 3027).

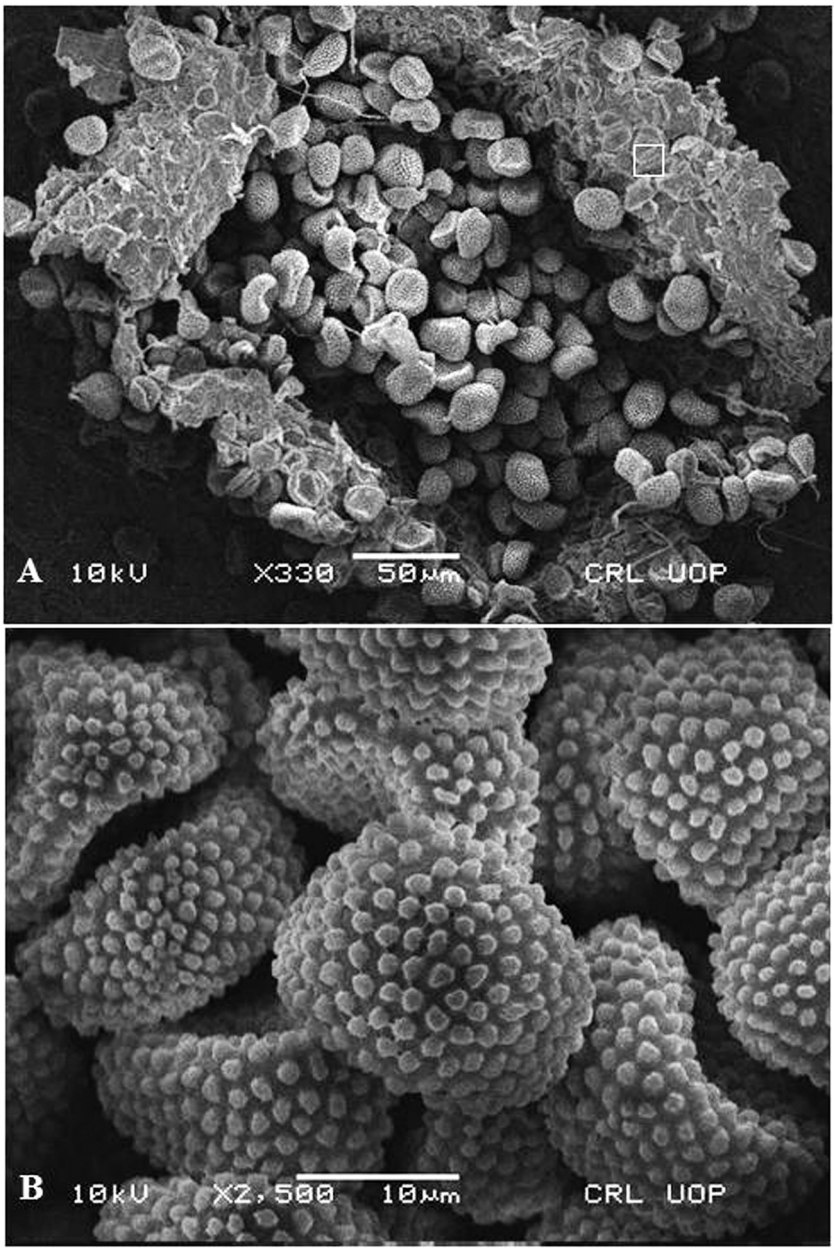

Fig. 1. *Chrysomyxa pyrolae* (SEM). (A) Uredinium with urediniospores and one-layered peridium (square). (B) Urediniospores with densely verrucose ornamentation.

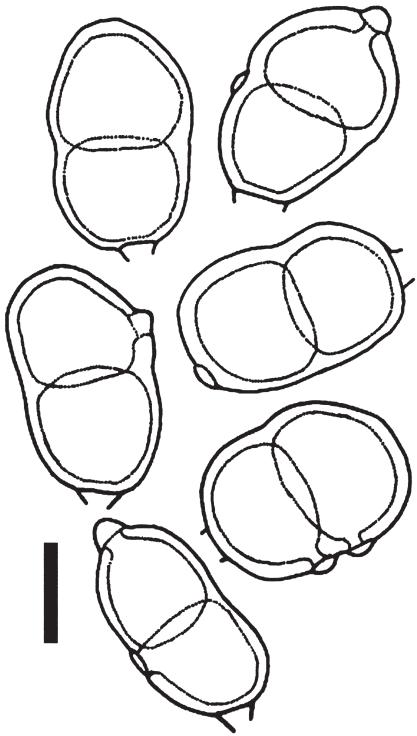

Fig. 2. *Puccinia aegopodii*. Lucida drawings showing position of germ pores on teliospores. Scale bar =15 µm.

Comments: Farr & Rossman 2011 have reported *P. aegopodii* from China and Mongolia on *Aegopodium alpestre.* Our report is an addition to the mycobiota of the Indian subcontinent.

Puccinia oniwaensis Hirats. f. & S. Sato, Trans. Mycol. Soc. Japan 3: 56 (1962). Fig. 3

Spermogonia and Aecia not seen. Uredinia hypophyllous, pulverulent, brown, intermixed with telia. Urediniospores subglobose, ellipsoid to obovoid, pale brown to brown, 15–20 × 22–27 µm; wall 1.2–2 µm, minutely echinulate, germ pores 2, supraequatorial. Telia hypophyllous, sometimes aggregated, pulverulent, black. Teliospores ellipsoid to oblong, rounded at both ends, chestnut brown, slightly or not constricted at septa, 20–22 × 27–34 µm; wall chestnut brown, verrucose, more dense in upper cell; 2–3 µm; germ pore apical in upper cell and near pedicel in lower cell; apex 3–4.5 µm, brown. One and three celled teliospores rarely present.

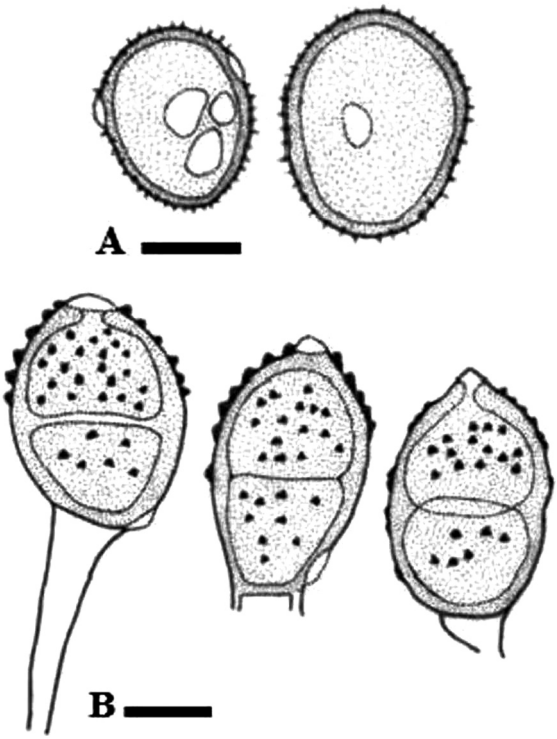

Fig. 3. *Puccinia oniwaensis* (Lucida drawings).
(A) Urediniospores showing minutely echinulate ornamentation.
(B) Teliospores with densely verrucose ornamentation. Scale bar =10 μm.

Material examined: **PAKISTAN**, **Northern Areas**, Deosai Plains, 3300 m a.s.l., on leaves of *Persicaria orientalis* (L.) Spach (*Polygonaceae*), with II + III stages, 10 Sep 2011, coll. Abdul Nasir Khalid, det. Malka Saba 15 (LAH).

Comments: *Puccinia oniwaensis* has been reported on *Polygonum sibiricum* Laxm. from Astore, Rama Lake (Baltistan, Northern Areas) by Khalid et al. (1995). *Persicaria orientalis* is a new host and *P. oniwaensis* is a new report for Deosai Plains.

Puccinia rhytismoides Johanson, Bot. Not.: 173 (1886). Fig. 4

Spermogonia, Aecia and Uredinia not seen. Telia hypophyllous, compact, subepidermal, loculate, surrounded by cylindrical paraphyses, 60–80 × 100–200 μm. Teliospores clavate, ellipsoid or oblong, 10–14 × 26–58 μm (mean 11.8 × 40.3 μm), pale brown or brown at apex, cinnamon brown at base, constricted at septum, lower cell longer than apical cell, attenuated at base;

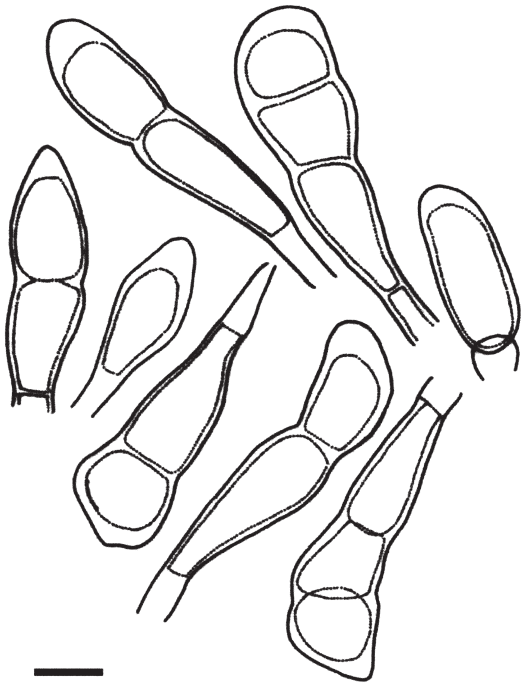

Fig. 4. *Puccinia rhytismoides.* Lucida drawings showing 1–3 celled teliospores. Scale bar =15 µm.

wall smooth, hyaline to pale brown, 0.5–1 µm thick; apex conical, truncated or rounded, 3–6 µm thick; pedicel dark brown, persistent, 4–7 × 3–13 µm. Mesospores common, pale brown, clavate or oblong, 8–10 × 18–30 µm; wall up to 1 µm thick, smooth; apex conical or rounded 4–6 µm; pedicel short, dark brown. Three-celled teliospores rare.

Material examined: **PAKISTAN**, **Northern Areas**, Deosai Plains, on leaves of *Thalictrum alpinum* L. (*Ranunculaceae*), with III stage, 10 Sep 2011, coll. Abdul Nasir Khalid, det. Malka Saba 16 (LAH). **FINLAND, Kilpisjärvi**, on leaves of *T. alpinum*, 12 Jul 1935, coll. & det. J.I. Liro (ZT Myc s. n.). **NORWAY**, **Trøndelag**, near Kongsvold, Doorefjeld, on leaves of *T. alpinum*, 1925, leg. A.G. Eliasson (ZT Myc s.n.).

Comments: *Puccinia rhytismoides,* which represents a new record for the Indian subcontinent, has previously been reported on *Thalictrum alpinum* from Alaska, Finland, Iceland, Norway, Russia, and Sweden and on *T. alpinum* var. *stipitatum* Y. Yabe and *T. tuberiferum* Maxim. in Japan (Farr & Rossman 2011). However Hiratsuka et al. (1992) placed *P. rhytismoides* in synonymy under *P. ustalis* Berk., which Ahmad et al. (1997) from Pakistan reported on *Anemone obtusiloba* D. Don.

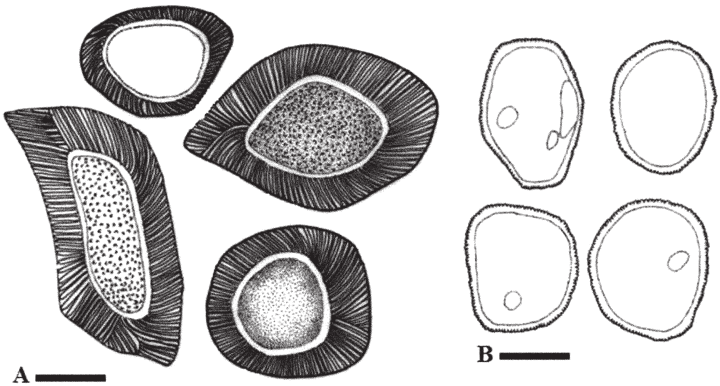

Fig. 5. *Puccinia swertiae* (Lucida drawings).
(A) Peridial cells showing densely verrucose ornamentation.
(B) Aeciospores with minutely verrucose ornamentation. Scale bar =10 µm.

Puccinia swertiae (Opiz) G. Winter, Rabenh. Krypt.-Fl., Ed. 2, 1(1): 205 (1881) ["1884"]. Fig. 5

Spermogonia and Uredinia not seen. Aecia on abaxial side, cupulate, yellowish, gregarious, 200–300 × 250–450 µm. Peridial cells yellowish brown, rhomboidal to oblong or irregular, 17.7–39 × 22–53 µm (mean 35.3–37.9 µm); wall densely verrucose, 2.8–8.5 µm. Aeciospores obovoid or subglobose, hyaline to brown, 19.6–25.2 × 20.5–27(–36) µm (mean 21.8 × 24.4 µm); wall finely verrucose, 0.5–1.2 µm. Telia abaxial, black, pulverulent, covered by ruptured epidermis, scattered, naked, 100–200 × 200–800 µm. Teliospores obovoid or ellipsoid, rounded at both ends, not or hardly constricted at septum, dark brown to chestnut brown, 25–30.4 × 31–39 µm (mean 27 × 35 µm); wall verrucose, 1.8–3.5(–4) µm; germ pores two, next to septum in both upper and lower cells, rarely apical in upper cell; apex dark brown to chestnut brown, not or slightly thickened, 1.2–2 µm; pedicel short, hyaline, persistent, 4–9.4 × 2.6–8.5 µm.

Material examined: **PAKISTAN**, **Northern Areas**, Deosai Plains, on leaves of *Swertia petiolata* D. Don (*Gentianaceae*), with I + III stages, 10 Sep 2011, coll. Abdul Nasir Khalid, det. Malka Saba 17 (LAH).

Comments: *Puccinia swertiae* has been reported on *Swertia petiolata* and *S. speciosa* Wall. from Kalam (Swat, Khyber Pakhtunkhwa), Sargodha, and Shogran (Kaghan Valley, Khyber Pakhtunkhwa) (Ahmad 1956a,b; Jorstad & Iqbal 1967; Ono & Kakishima 1992; Ono 1992). *Puccinia swertiae* represents a new record for Deosai Plains.

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